Bankruptcy Prediction in the WorldCom Age

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Abstract

For decades, considerable accounting and finance research was directed at creating a model for predicting bankruptcy. Early attempts to discover a single best accounting-based predictor eventually gave way to more comprehensive models involving both accounting- and market-based indicators. This paper reviews one of the most popular of those bankruptcy prediction models, the Z-score model developed by Edward Altman in 1968. Also included is a brief discussion of later developments in credit analysis.

Introduction

According to Pate (2002), 257 public companies, with total assets of $256 billion, filed for bankruptcy in 2001. That this is the highest number of bankruptcy filings since 1980 is alarming. Furthermore, it is uncomfortably large compared to the number of filings during the last recession (125 filings in 1991 and 91 filings in 1992). Pate further estimates the likely number of public company bankruptcy filings in 2002 will be about 200, 22 percent below the 2001 level, but still well above the 1986-2000 average of 113.

Another clearly visible trend is the increase in the number of large companies going bankrupt. Altman (2000) points out that bankruptcy in firms with large asset size, while quite rare prior to 1966, became more common in 1970s. According to Altman, since the enactment of the current U.S. Bankruptcy Code in 1978, there were at least 100 Chapter 11 bankruptcies of firms whose asset size exceeded $1 billion.

In this environment, business leaders and finance professionals would be well advised to refresh their knowledge of bankruptcy prediction models. Fortunately, those models have been around for a while. The present paper is intended to serve as an introduction into one of the most popular bankruptcy prediction models, the Z-score model developed by Edward Altman in his pioneering 1968 paper.

The Z-score Model

For decades, considerable accounting and finance research was directed at finding a ratio that would serve well as a predictor of bankruptcy. One of the most comprehensive studies of that early era was Beaver (1967). Beaver studied the

performance of various ratios as bankruptcy predictors and concluded that the cash flow to debt ratio was the single best predictor.

The critical breakthrough in bankruptcy prediction came with Altman (1968). Altman decided to abandon the search for a single best ratio and built a comprehensive, statistical model using a technique called multiple discriminant analysis (MDA). MDA allows a researcher to group observations into several pre-determined categories based on several characteristics of an observation. Altman selected a sample of 33 manufacturing companies that filed for bankruptcy in 1946-65 and matched them with another 33 companies selected on a stratified (by both industry and asset size) random basis.

Altman then started with 22 ratios that seemed to be intuitively plausible as bankruptcy predictors. After every run, he excluded the ratio that contributed least to the explanatory power of the model. Eventually, he came up with a model that contained only five ratios. The original Altman model took the following form:

$$Z = 0.012\ X_1 + 0.014\ X_2 + 0.033\ X_3 + 0.006\ X_4 + 0.999\ X_5 \qquad (1)$$

where

X_1 = working capital/total assets,

X_2 = retained earnings/total assets,

X_3 = earnings before interest and taxes/total assets,

X_4 = market value of equity/book value of total liabilities, and

X_5 = sales/total assets

In the initial 1968 study, Altman used a cutoff Z-score of 2.675. In other words, if the Z-score was below the cutoff line, the firm was classified as bankrupt (i.e.,

insolvent or headed that way), if above, as non-bankrupt. This allowed him to correctly classify 94% of the bankrupt firms and 97% of the non-bankrupt firms one year prior to the filing of bankruptcy. An attempt to predict bankruptcy two years in advance yielded lower, but still impressive, accuracies of 72% and 94%.

It is important to emphasize that the original Altman model is intended for use in cases of publicly traded *manufacturing* firms. However, Altman has used the same approach to develop other models; Z′ for privately-held firms and Z″ for non-manufacturing firms.

In the original version, all ratios were stated in percentage points, except X_5, stated as an absolute value. For example, if EBIT/total assets ratio were 15%, or 0.15, X_3 would be assumed to equal 15. Eventually, a more convenient specification was proposed:

$$Z = 1.2\ X_1 + 1.4\ X_2 + 3.3\ X_3 + 0.6\ X_4 + 1.0\ X_5 \qquad (2)$$

In this specification, an EBIT/total assets ratio of 15% would result in X_3=0.15. X_5, similarly to the original version, is stated as an absolute value. Altman himself used this version in Altman and LaFleur (1981).

After conducting three subsequent tests (86 companies gone bankrupt in 1969-75, 110 in 1976-95, and 120 in 1997-99), Altman recommended a lower cutoff score of 1.81. Interestingly enough, Altman (2000) noted that in 1999, 20% of U.S. industrial firms referenced in Compustat data tapes had Z-scores below 1.81. In other words, the unusually high incidence of bankruptcy in 2001-02 was to be expected!

But What If the Books Are Cooked?

An interesting feature of the Z-score model is its ability to withstand certain types of accounting irregularities. Consider a recent high-profile bankruptcy of WorldCom, where management improperly recorded billions of dollars as capital expenditures instead of operating expenses. Such a treatment would have a twofold impact on financial statements: (1) overstating earnings, and (2) overstating assets. Overstated earnings would increase the X_3 ratio in the Z-score model, while overstated assets would actually *decrease three ratios*, X_1, X_2, and X_5 (all three are calculated with total assets in the denominator). The overall impact of these accounting improprieties on the company's Z-score, therefore, is likely to be downward.

To examine the validity of this reasoning in a limited case-study setting, we computed Z-scores for WorldCom for fiscal years ending December 31, 1999, 2000, and 2001 based on its annual 10-K reports filed with the U.S. Securities and Exchanges Commission (see **Table 1**). We found that the company indeed experienced a rapid deterioration in its Z-score. Obviously, this limited test has to be taken with a grain of salt (especially given that WorldCom is not a manufacturing company), but it does show how this particular type of accounting impropriety can affect the Z-score.

Later Developments

As noted above, one innovative aspect of Altman (1968) was its radical departure from the search for a single best ratio. Rather, he sought a simple, yet comprehensive, multivariate model. Another equally innovative and equally radical idea was to use a *combination of accounting and market-based indicators* to forecast bankruptcy. At the

time, finance scholars often questioned the validity of accounting measures, while accounting researchers thought that observing the *equity* market had little to do with *debt*-related issues such as bankruptcy.

The significance of this synthesis was not fully understood until the advent of option pricing models. First, in a seemingly unrelated development, Black and Scholes (1973) and Merton (1973) discovered a mechanism for rational option pricing, which, incidentally, depended on both the price of underlying shares and the *volatility* of that price. Then, Vasicek and Kealhofer (see Crosbie (2002) for an extensive discussion of the Vasicek-Kealhofer model) proposed to view equity as a call option on the firm's assets with a strike price equal to the book value of the firm's liabilities. This approach permits an estimate of the probability of default within a specified period of time based on both accounting (the value of liabilities) and market (the share price and volatility) data.

These and other related developments have lead to the emergence of a new school in credit analysis and fixed-income portfolio management. The underlying mathematics of the Vasicek-Kealhofer model and other modern credit risk models is sometimes quite complex, but the general idea first proposed by Altman – a comprehensive synthesis of accounting and market-based measures – still remains the cornerstone of contemporary credit analysis.

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Table 1. Z-score Analysis for WorldCom (accounting data prior to restatements)

Ratio	Definition	1999	2000	2001
X_1	Working capital/total assets	(0.08)	(0.08)	(0.00)
X_2	Retained earnings/total assets	(0.01)	0.03	0.04
X_3	Earnings before interest and taxes/total assets	0.08	0.08	0.02
X_4	Market value of equity/book value of total liabilities	3.58	1.13	0.54
X_5	Sales/total assets	0.39	0.40	0.34
Z	**Z-score**	**2.697**	**1.274**	**0.798**